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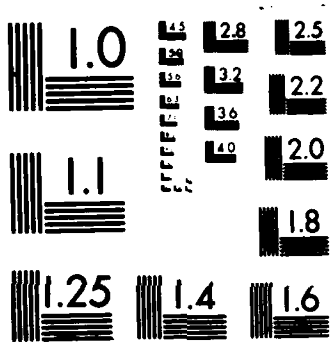

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1985 Small Propeller-Driven Aircraft Noise Test Program

AD-A175 596

October 1985

Preliminary Report

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16. Abstract

The international aviation community is currently reviewing noise certification procedures for small propeller-driven aircraft. Under discussion is a proposal to substitute a ground-plane microphone for the currently specified elevated microphone as a means of suppressing spectral irregularities. Given the strong low and mid-range tonal frequencies attendent to propeller-driven aircraft, the constructive/destructive interference pattern in an aircraft frequency spectrum can result in inconsistent certification test results for aircraft with different blade passage frequencies. The Federal Aviation Administration conducted seversl flight tests during the summer of 1985 in-order-to compare noise levels measured at four feet to ground-plane levels as a function of blade passage frequency. The purpose of this report is to present a preliminary assessment of the data acquired during the flight tests. A more comprehensive analysis of the test results will be documented in the final report.

Three flight tests were performed using a Cessna 210, Cessna Caravan I, and a (Beechcraft) U.S.NAVY T-34C. A vertical array(3.75 to 7.0 ft.) of microphones and a range of test RPMs were used in-order-to test the theoretical prediction of the ground reinforcement effect. As a secondary objective, the microphones were redeployed in horizontal arrays to test for a difference in variability between elevated and ground-plane microphones. The primary installation for the ground-plane microphone was over a 0.4 meter circular metal plate. A comparison was also made between 0.4 meter and 36 inch diameter ground plates.

Experimental results generally confirm the presence of signal reinforcement, and the consequent influence on maximum dBA levels, as a function of blade passage frequency. However, the magnitude of the measured reinforcement, when compared to predicted values, varies by up to 2 dBA for different aircraft. The microphone variability test revealed equally good agreement between the elevated array microphones and the ground-plane array microphones. Finally, the 0.4 meter ground-plane plate generally gave lower dBA values compared to the 36 inch plate--varying from a minor difference at the lowest RPMs tested to a difference as high as 1.7 dBA at the highest RPM tested.

17. Key Words

aircraft,propeller,acoustics,noise flight test, certification

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1.0 Introduction - The issue of regulating community noise impact from small propeller-driven aircraft has been addressed by the Federal Aviation Administration (FAA) through the aircraft certification process (FAR Part 36 Appendix F). Briefly, the FAA certification procedure calls for the measurement, at a four foot elevation, of the maximum A-weighted (slow response) sound pressure level produced by the test aircraft in level powered flight at 1000 feet above ground level (AGL). The International Civil Aviation Organization (ICAO) independently adopted a similar procedure for small propeller-driven aircraft.

The ICAO has under consideration of a proposal to replace the level flyover testing procedure with a takeoff test. Under the auspices of the ICAO Committee on Aviation Environmental Protection, Working Group II of the Committee on Aircraft Noise has addressed several problem areas in the effort to develop a takeoff test which is of equal stringency to the level flyover test.

In addition to those problem areas unique to a takeoff test, the ICAO working group is considering another problem common to both testing procedures -- spectral irregularities associated with the use of an elevated microphone. Given the strong low and mid-range tonal frequencies attendent to propeller-driven aircraft, the constructive/destructive interference pattern in an aircraft frequency spectrum can result in inconsistent certification test results for aircraft with different blade passage frequencies. The United Kingdom has proposed to the ICAO working group the substitution of a ground plane microphone as an attempt to achieve a noise certification measurement procedure which is consistent for all models of small propeller-driven aircraft.

The FAA Office of Environment and Energy conducted several flight tests during the summer of 1985 in order to compare noise levels measured at four feet versus ground plane levels as a function of blade passage frequency. The purpose of this report is to present the preliminary data measured during the flight tests for consideration by the ICAO working group. A more comprehensive analysis of the test results will be documented in a future report.

2.0 Background -

2.1 Microphone Installation Effects - The microphone position presently required by the FAA (four foot) and ICAO (1.2 meter) certification procedure is illustrated in figure 1. In addition to the direct acoustic wave from the aircraft, the indirect wave reflected from the ground surface is also sensed by the microphone. The direct and phase-shifted reflected waves instantaneously add leading to a pattern of constructive and destructive interferences in the noise frequency spectrum of the aircraft.

The shape of the interference pattern is a function of the geometrical aspects of the source/microphone, ground surface, and sound frequencies. Considering a pure tone source, with an infinitely narrow bandwidth and located directly over the elevated microphone, the theoretical ground interference of a four foot microphone mounted over an acoustically hard surface is illustrated in figure 2. The sound pressure level (SPL) will increase by 6 dB for reinforcements and will be negative infinity for the cancellations. The theoretical frequencies of maximum reinforcement (F_R) and cancellation (F_I) are as follows:

$$F_R = (C)(n)/2H(\mathrm{SIN}\ \emptyset) \qquad \text{eq. 1}$$
$$F_I = (C)(n + 1/2)/2H(\mathrm{SIN}\ \emptyset) \qquad \text{eq. 2}$$

where: C = speed of sound
H = microphone height
$\emptyset$ = aircraft receiver angle (Figure 1)
n = nonnegative integer

Current certification testing procedure calls for the four-foot microphone measurements to be made over a grass surface. The effects of measuring over an absorbing surface are to decrease the magnitude of the sound pressure oscillations caused by the interference, and shift the interference pattern to lower frequencies because of a shift in the phase angle.

2.2 Ground-Plane Microphone - The three types of ground-plane microphones in common use are illustrated in figure 3. The true flush mount is a normal incidence microphone mounted with the diaphragm flush with the reflecting surface. The lying mount is a grazing incidence microphone lying on the reflecting surface with the diaphragm parallel with the flight track of the aircraft. The inverted mount is a normal incidence microphone mounted inverted over, and a very short distance above the reflecting surface. The true flush microphone, when mounted in a large, flat, and acoustically hard surface, will measure a sound pressure level that is 6 dB higher than free field at all frequencies and incidence angles. However, use of a true flush mount in aircraft flight testing is often impractical. The lying and inverted microphone are attempts to approximate the true flush mount and can be reasonably representative of the true flush mount.

FIGURE 1. Acoustic Waves Received by an Elevated Microphone

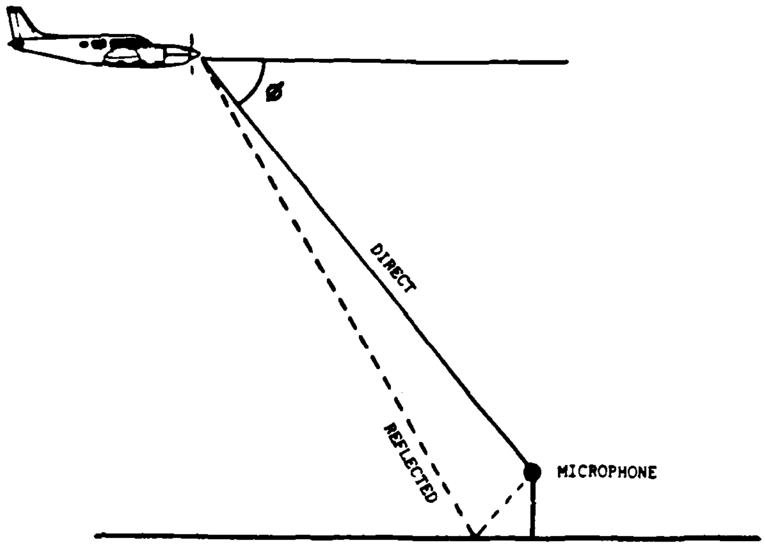


FIGURE 2. Theoretical Ground Interference for a 4 ft. Elevated Microphone

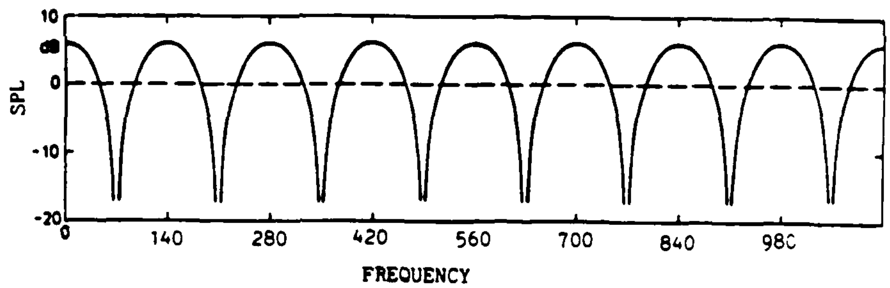
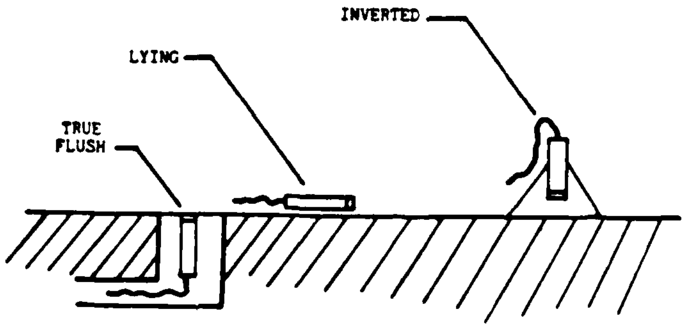


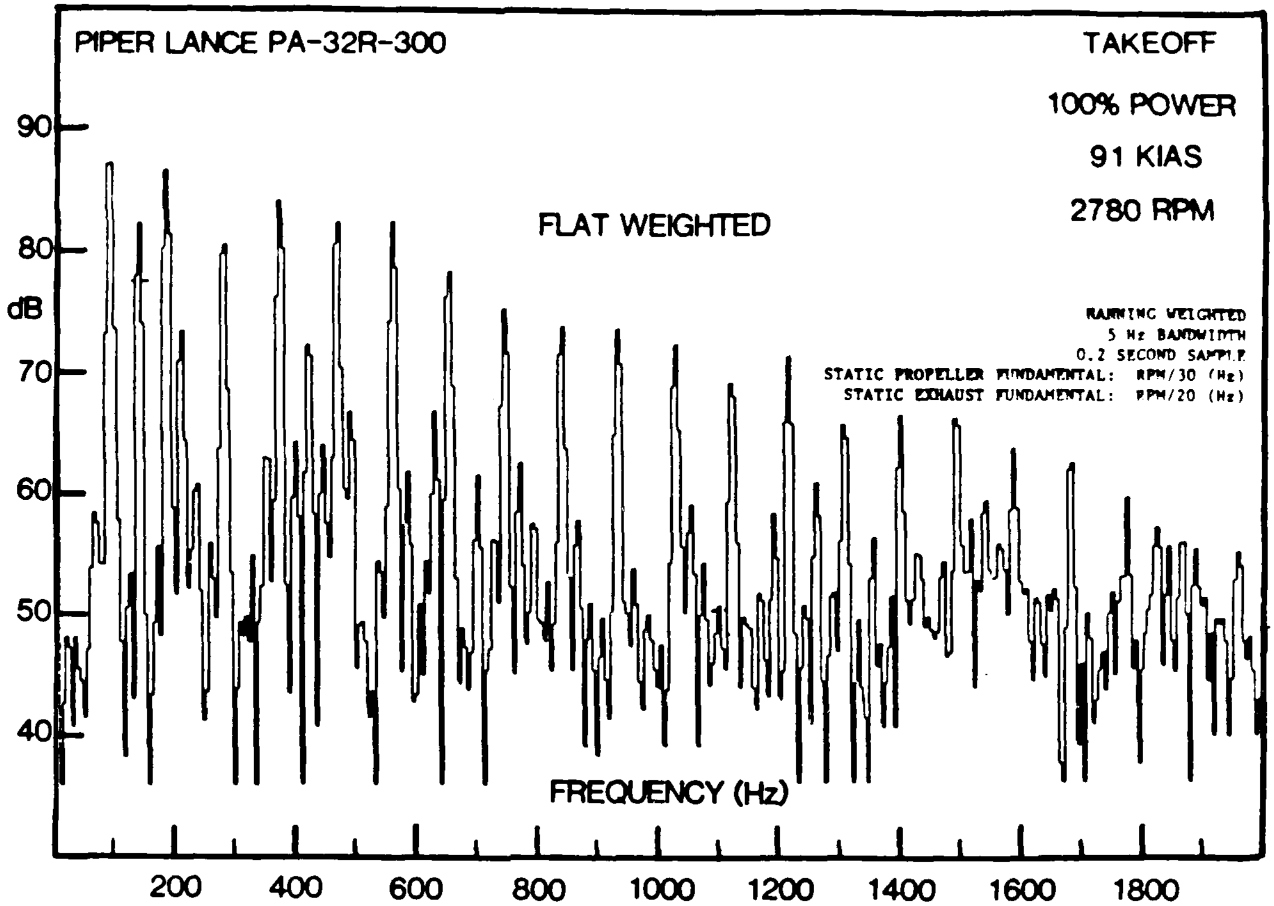
FIGURE 3. Ground-plane Microphones



For purposes of certification of small propeller-driven aircraft, the United Kingdom has proposed to the ICAO working group the use of an inverted microphone as the required ground-plane measurement procedure in replacement of the present requirement for an elevated microphone. Details of the United Kingdom proposal (reference 1) are as follows: "The microphone with its protective grid shall be mounted in an inverted position such that the microphone diaphragm is 7 millimeters above either a hard surface or a circular metal plate. If measuring over a hard surface the local surface should be smooth and flat. An area at least 2 meters radius around the microphone should be painted white, and the microphone should be at least 5 meters from the edge of the concrete. If not measuring over a hard surface, a white-painted circular metal plate, 0.4 meters diameter and at least 2.5 millimeters thick should be made flush with the surrounding ground surface with no cavities below the plate. The microphone should be located at 3/4 radius from the centre of the plate, in a direction normal to the line of flight."

2.3 Propeller-driven Aircraft Noise Spectra - Figures 4a and 4b are flat-weighted and A-weighted narrowband frequency spectra, respectively, of the acoustic signal from a small 2-blade propeller-driven aircraft. Components immediately identifiable in the spectrum are the fundamental and harmonic tones of the propeller, engine exhaust, and half-order tones from the exhaust. Note that the harmonic tones of the propeller and engine exhaust periodically are combined as a single tone. Note also that the harmonic tones in the frequency range of 200 to 1000 hertz dominate the maximum A-weighted sound pressure level for the full power takeoff spectrum depicted. The relatively sharp tonal content of the propeller aircraft spectrum indicates that the spectrum is susceptable to overall sound pressure level changes as the spectrum moves toward lower frequencies via doppler shift through the interference zones depicted in figure 2. This effect is illustrated in the successive spectra presented in figure 5. In practice, the infinitely narrow bandwidth is not entirely representative of the noise emissions from an aircraft flyover. The tonal bandwidth from a propeller aircraft is some finite value due to the frequency doppler shift during the sampling interval of the measuring instrumentation. This results in a "slurring" of the maximum/minimum interference function (figure 2) which in turn results in a decrease in the theoretical ground interference range of +6 dB to $-\infty$ dB.

FIGURE 4 Examples of Propeller Aircraft Noise Spectra



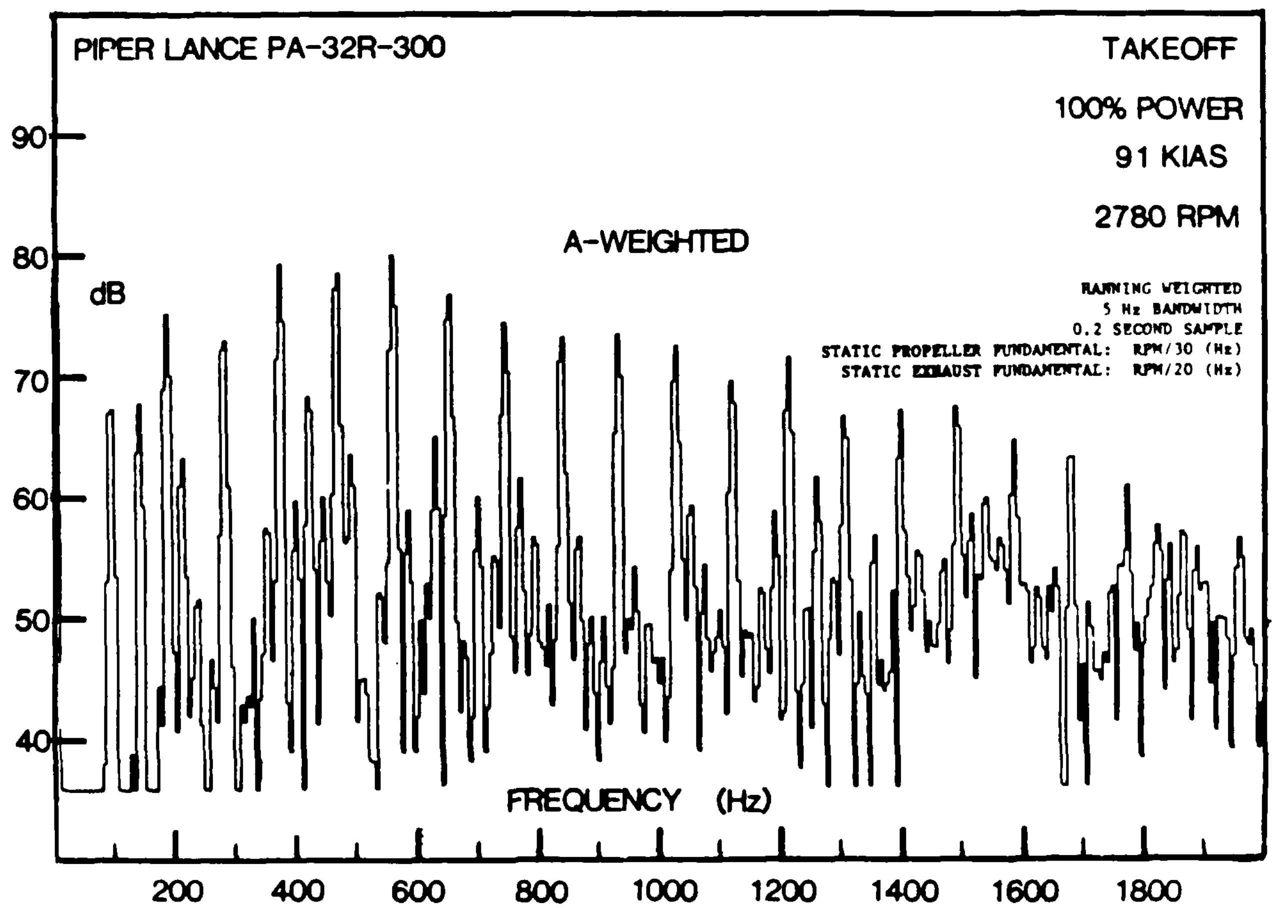
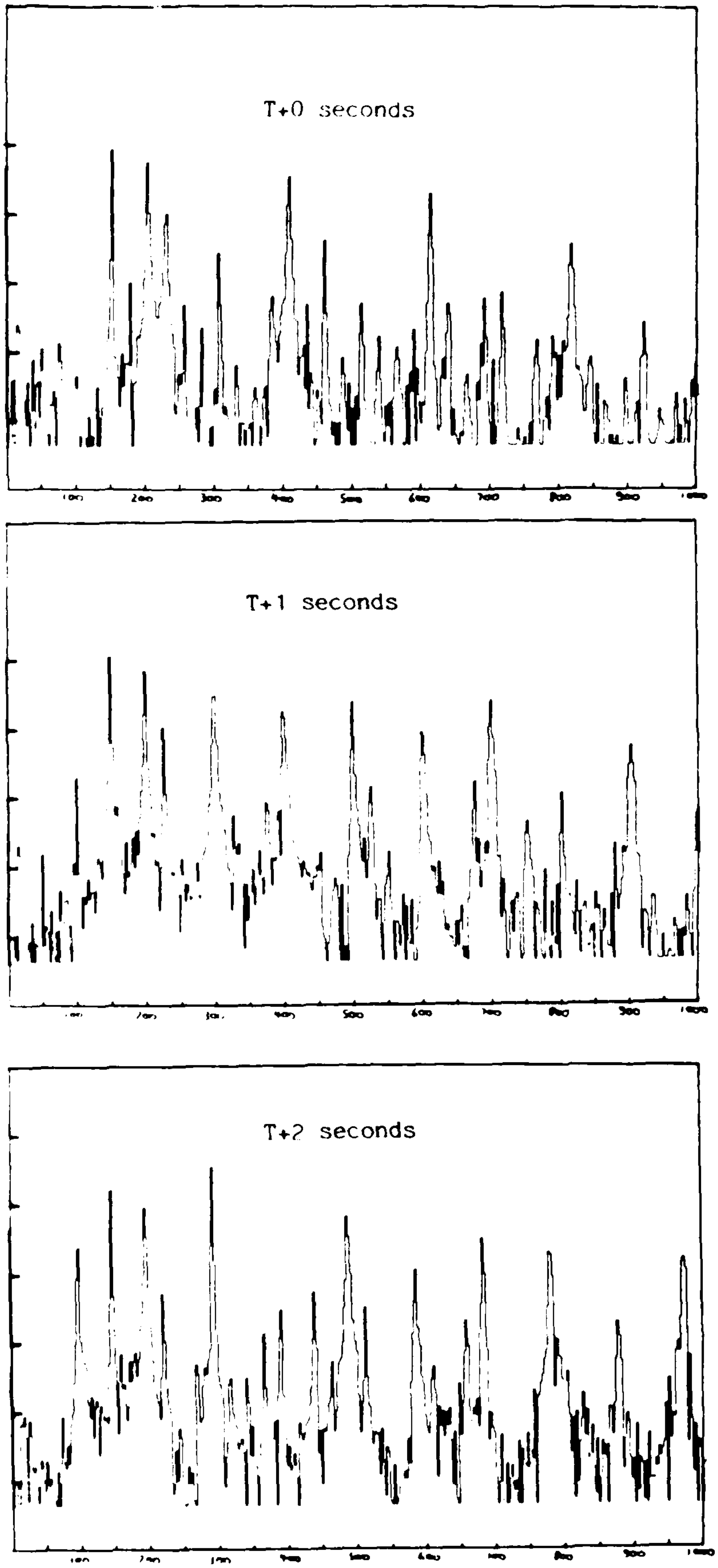


FIGURE 5 Example Spectral Irregularities With an Elevated Microphone



3.0 Flight Testing Procedure

3.1 Objective - The primary objective of the three propeller aircraft flight tests was to examine the difference in maximum A-weighted sound pressure levels between an elevated microphone and a ground-plane microphone as a function of propeller blade passage frequency. Elevated measurements were made over grassy areas per the requirements of current international aircraft noise certification procedures. The ground-plane measurements were made using a 0.4 meter metal disk as recommended by the United Kingdom for certification of propeller aircraft.

A secondary objective was to examine the variability in measured sound pressure levels from an array of elevated and ground-plane microphones under identical noise source and microphone installation conditions. Another secondary objective was to examine the difference in ground-plane sound pressure level between a 0.4 meter and a 36 inch (0.91 meters) diameter circular reflecting surface for a given flyover.

The tests were restricted to single engine propeller-driven small aircraft and included piston engine and free-turbine type turboprop aircraft.

3.2 Logistics - The 1985 tests were conducted during the summer at the Washington Dulles International Airport. The acoustic measurement area was located in the flat grassy overrun area of runway 30. The array of microphones were concentrated at a point 925 feet from the runway threshold along the extended runway centerline. The test window available was 1000 to 1400 hours local time DST. One aircraft was tested on each test day. A Cessna 210 was tested on July 9. The two turboprop aircraft, a T-34C and a Cessna Caravan I, were tested on July 30 and August 28, respectively.

3.3 Test aircraft

3.3.3 Cessna 210 - The Cessna 210 Centurion (figure 6) is a single engine aircraft with a 300 horsepower Continental IO-520-L flat six normally aspirated engine driving a McCauley three-blade constant-speed metal propeller. Diameter of the propeller is 80 inches. The airspeed for best rate of climb at maximum takeoff weight is 98 knots. Takeoff distance to clear a 50 foot obstacle is 2030 feet. Maximum rate of climb is 950 feet per minute. Performance figures are for maximum weight and power and corrected to sea level. The 210 was rented locally for the test.

3.3.2 T-34C - The July 30 test was conducted with a U.S. Navy T-34C (figure 7) with a Pratt and Whitney/Canada PT6A-25 turboprop engine (torque limited from 715 shp to 400 shp) driving a Hartzell three-blade constant-speed metal propeller. Diameter of the propeller is 90 inches. The T-34C with test pilot was supplied by the U.S. Navy Naval Air Test Center at Patuxent River, Md. Air speed for best rate of climb is 120 knots. Takeoff distance to clear a 50 foot obstacle is 1950 feet. Maximum rate of climb is 1480 feet per minute.

FIGURE 7 U.S.NAVY T-34C

FIGURE 6 CESSNA C-210

FIGURE 8 CESSNA CARAVAN I

3.3.3 Caravan I - The August 28 test used a Cessna Caravan I, a single engine turboprop (figure 8) with a Pratt Whitney/Canada PT6A-114 free-turbine engine with 600 shp at 1658 ft/lbs torque and 1900 RPM driving a Hartzell three-blade constant speed kevlar propeller. Diameter of the propeller is 100 inches. The airspeed for best rate of climb is 105 knots. Takeoff distance to clear a 50 foot obstacle is 1665 feet. Maximum rate.of climb is 1215 feet per minute. The Caravan with a factory pilot was provided by the Cessna Aircraft Company, Wichita, Kansas.

3.4 Data Acquisition Systems

3.4.1 Acoustic - The same microphone placements were used in the three tests with the exception of the height of the elevated microphones. Five grazing incidence microphones were used in the vertical array. One microphone was always at 4 feet elevation as a reference for all three tests. The other four microphones were placed in a vertical array at three inch intervals. The required height of the vertical array was a function of the available blade passage frequency from each test aircraft (Refer to section 3.6 for further discussion of microphone height). Grass in the measurement area was sparse due to the combination of dry weather during the summer, mowing by airport maintenance, and trampling by the research team. Thus, the complication of measuring over a lush grassy surface was not a problem. Microphone height, determined by a 1.5 inch diameter wooden rod resting on the surface, was measured to the center of the microphone (mounted in a horizontal position with the diaphragm parallel to the flight track).

A ground plane microphone was mounted over a 0.4 meter metal plate as specified in the United Kingdom proposal to ICAO (see section 2.2). The 0.4 meter diameter versus 1/8 inch (3.2 mm) thickness white painted aluminium plate was the primary ground-plane microphone (figure 9). A second inverted ground-plane microphone was positioned over a white painted pine wood disk one inch thick 36 inches in diameter . Each ground-plane disk was countersunk into the soil on top of a thin layer of sand to provide even support for the entire disk. The disk was mounted with the top of the disk flush with the surrounding soil. The microphone was placed at a 3/4 radius from center normal to the flight track.

The acoustic signals from the four elevated and two ground-plane microphones were recorded on FM magnetic recorders for subsequent laboratory analysis. A digital recorder recorded the signal from the 4 foot and the primary ground-plane microphones. An IRIG-B time code generator synchronized the acoustic systems with the aircraft trajectory tracking systems. Signals from three of the elevated and the primary ground plane microphones were monitored with handheld precision sound level meters (GENRAD 1988 and B&K 2233) for obtaining immediate results during the flight test. The maximum time between calibrations of the acoustic systems was one hour.

FIGURE 9 0.4 Meter Ground-plane Microphone

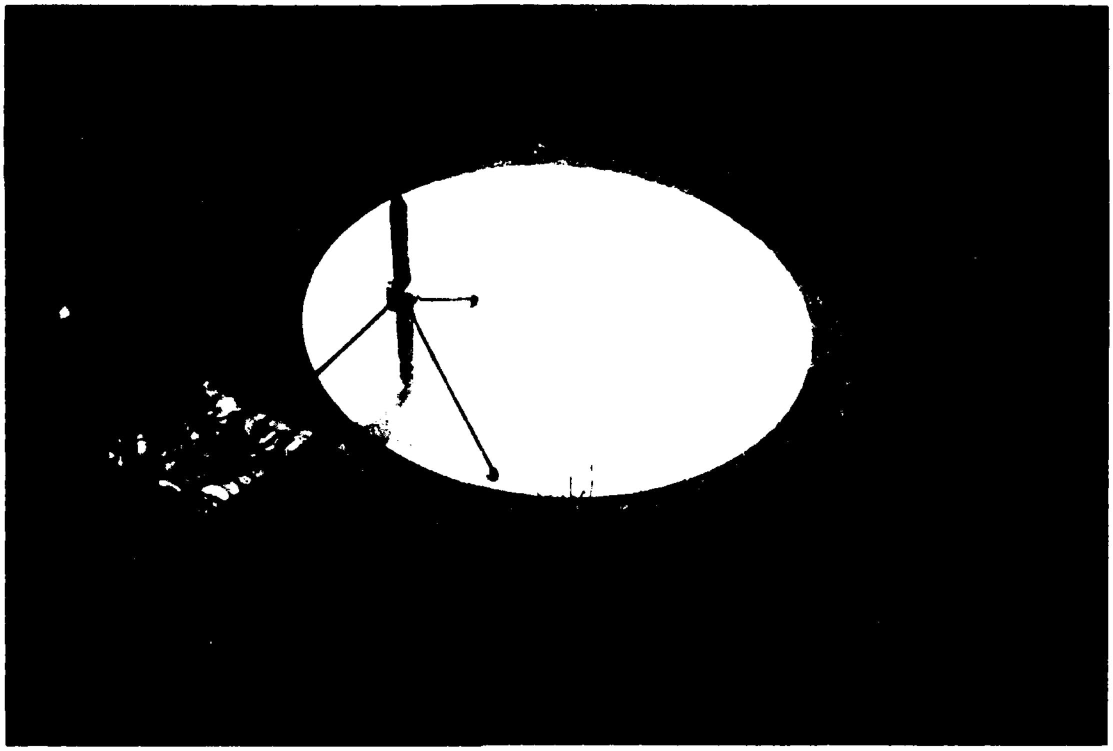
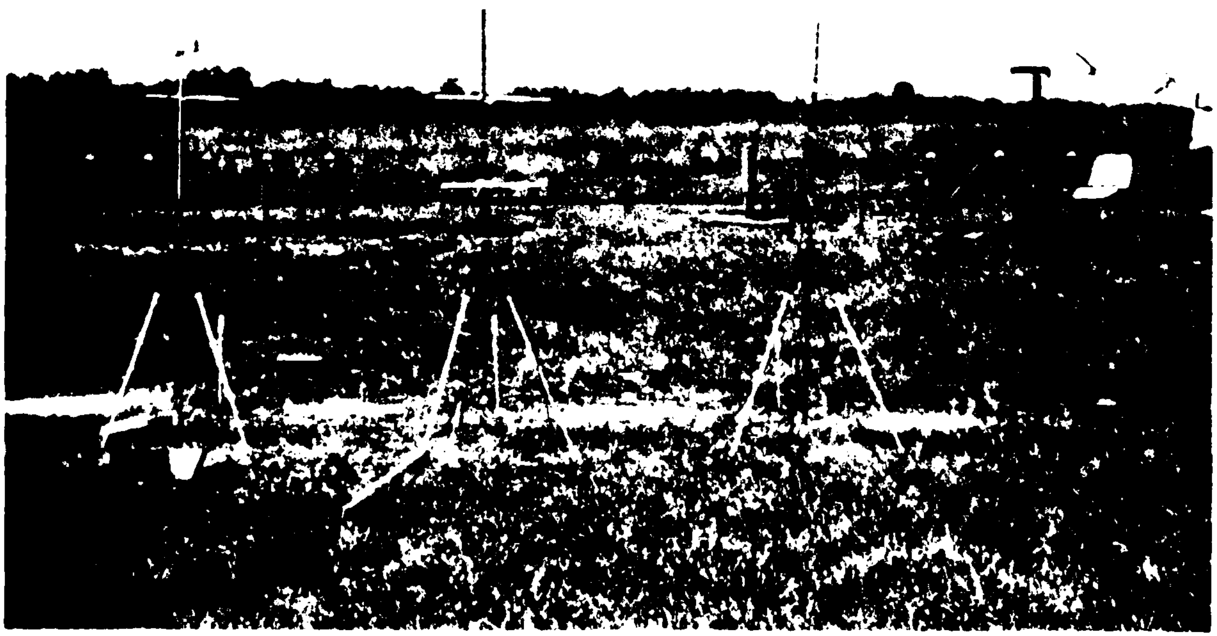


FIGURE 10 Microphones Deployed in Horizontal Arrays



At the conclusion of the elevated versus ground-plane microphone portion of the test, the microphones were re-positioned to address the secondary objective of microphone variability under identical sound source and microphone installation conditions. Three of the microphones were mounted in a horizontal elevated array. Three other microphones were placed in an array of ground-plane systems on 0.4 meter plates. The digital recorder continued to record a four foot microphone signal and one of the ground-plane microphones. Figure 10 shows the secondary objective array. Elevated and ground-plane microphones were placed at five foot intervals with the ground-plane microphones placed five feet "behind" the elevated microphones relative to the direction of the aircraft flight track.

3.4.2 <u>Aircraft Position</u> - The test aircraft was tracked and recorded with a trajectory tracking radar system. Aircraft altitude was also measured by a photoscaling procedure described in SAE AIR-902 (reference 2). The time of direct-overhead of the aircraft was measured with stopwatches synchronized with the time code generator for the acoustic and radar data recording systems.

3.4.3 <u>Meteorology</u> - Wind speed and direction at 10 meters were continuously recorded during the test. Temperature and relative humidity were recorded near ground level with an Assmann Psychrometer. The test aircraft occasionally measured outside air temperature during the test.

3.4.4 <u>Cockpit</u> - A cockpit observer accompanied each test aircraft. The observer handled air/ground communications, recorded cockpit instrument readings, and generally managed the airborne aspects of the test. Air speed, engine RPM, altitude, and manifold pressure or torque were recorded for each flyover as the aircraft crossed over the microphone.

3.4.5 <u>Flight Operations</u> - The test aircraft were flown in a racetrack pattern parallel with runway 30. The flight track for the measurement leg of the pattern was along the centerline and extended centerline of runway 30.

All test flyovers (events) during the three days of testing were simulated takeoffs at a rate of climb which sustained Vy (air speed for best rate of climb). The takeoffs were simulated as follows: Entering the measurement leg of the pattern, the pilot would set the desired RPM and, with reduced power, establish an airspeed of Vy in level flight. At a pre-determined point marked on the ground by fabric markers, the pilot would apply the prescribed test power, rotate, and climbout at that climb angle which would sustain Vy.

The reference altitude, defined as the altitude achieved at 8200 feet from brake release point, was previously calculated from Vy, D_{50} and maximum rate-of-climb consistent with the proposed ICAO noise test takeoff procedure. The altitude at which the rotation occurred was adjusted during the test such that the aircraft would approximately achieve the reference altitude over the noise measurement point.

A radio command was transmitted from the ground when the aircraft crossed the microphone to assist with the rotation altitude adjustment process and to indicate when to record data from the cockpit instruments. Another ground-based observer positioned along the flight track radioed commands to the pilot to correct any lateral deviation from the flight track. A "run over" command was radioed to the aircraft terminating the measurement leg when the desired acoustic signal and dB downpoints were observed.

3.6 Test Procedure

3.6.1 Background - The primary objective of the flight tests were to experimentally document the difference in maximum A-weighted sound pressure levels (slow response) measured at an elevated microphone versus the primary ground-plane microphone (delta SPL(h)) -- and how that difference varies as a function of propeller blade passage frequency (BPF) where:

BPF = (propeller RPM) x (no. of blades)/60 eq. 3

The theoretical pure tone relationship illustrated in figure 2, adjusted to incorporate the effects of an absorptive ground surface, was used in a procedure described by Heller (reference 3) to produce a series of delta SPL(H) versus BPF curves for a variety of microphone heights. A typical curve for a given microphone height is shown in Figure 11. As shown in subsequent figures, the curve will shift to the left and the dominant peak will narrow as microphone height increases. The curves were developed for propeller tones only and assumed a 20 dB linear rolloff from the propeller fundamental to the 10th harmonic.

The availability of test aircraft and a given aircraft's range in blade passage frequency dictated the microphone heights chosen for the experiments. By using multiple microphones and a range of engine RPMs, various parts of the delta SPL(H) versus BPF curve were tested.

Single propeller aircraft were used to avoid complications from multiple propeller sources. Both reciprocating and turboprop engined aircraft were tested in order to separate the exhaust and propeller components of the acoustic signal. Turboprop aircraft required free-turbine power plants in order to achieve a range of RPMs required by this study.

3.6.2 July 9 Test - The Cessna 210 with a 2850 RPM engine and a three-blade propeller was the only readily available single engine aircraft capable of producing a BPF corresponding to the peak of the delta SPL(H) versus BPF curve for a four foot microphone height. The other microphones in the vertical array were placed at 3.75, 4.25, and 4.5 feet. Engine RPMs of 2850, 2750, 2700, and 2550 corresponding to BPFs of 142.5, 137.5, 135, and 127.5 respectively were tested. The test variables are illustrated in figure 12a and the relative test points for a composite curve shown in figure 12b.

Figure 11 Difference in Noise Levels (elevated minus ground) versus Blade Passage Frequency

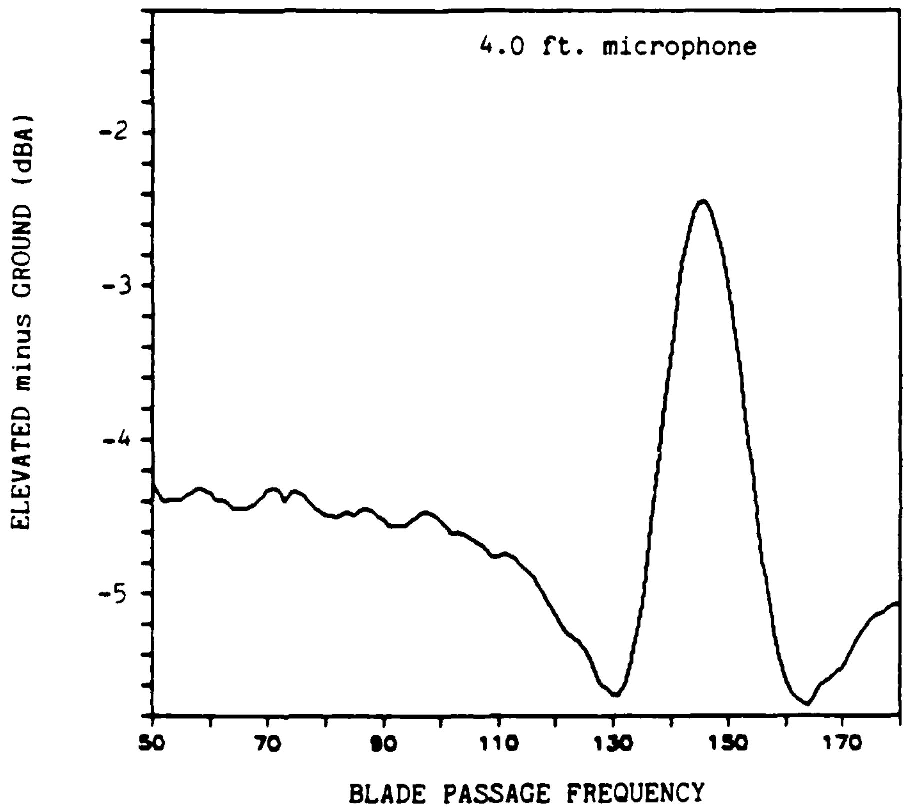
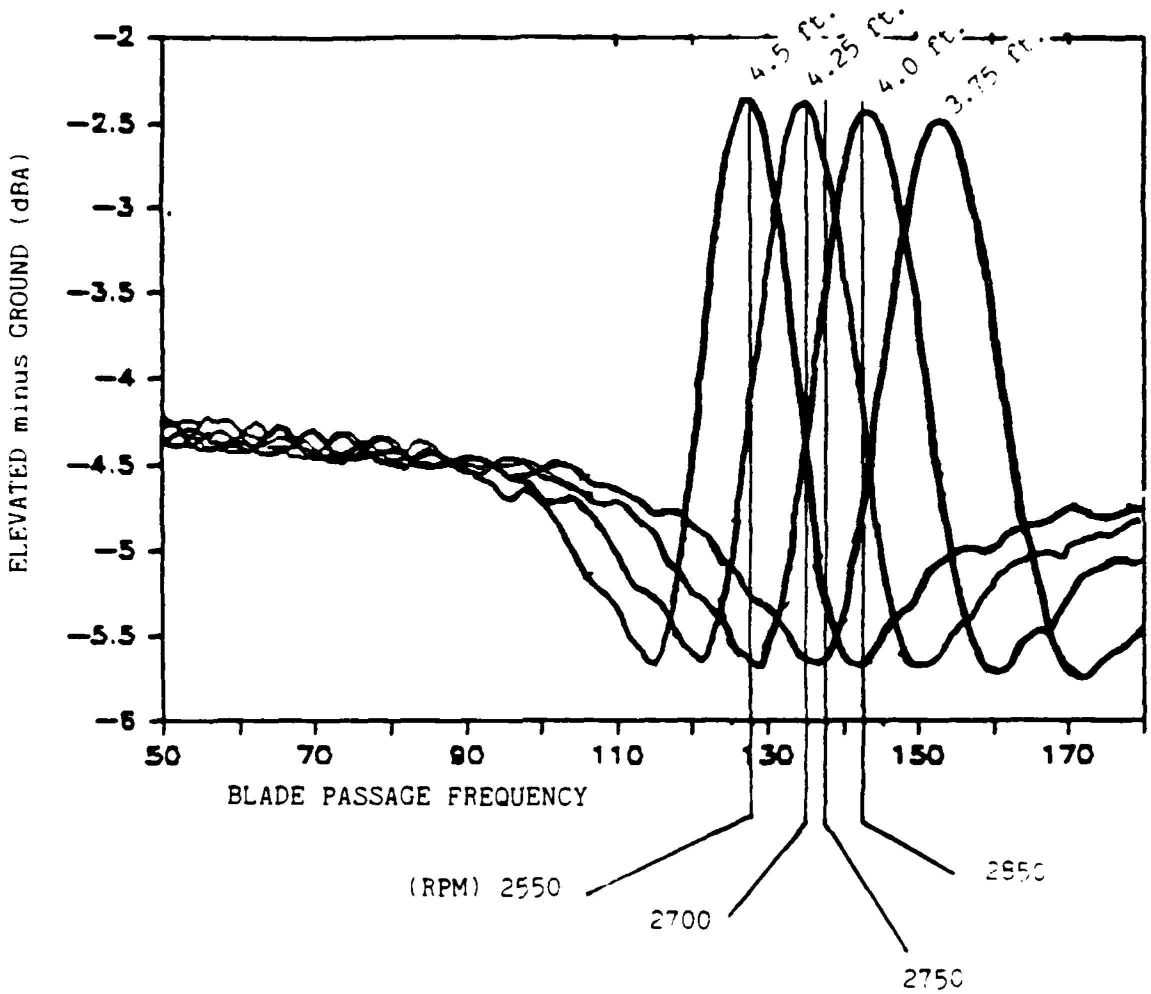
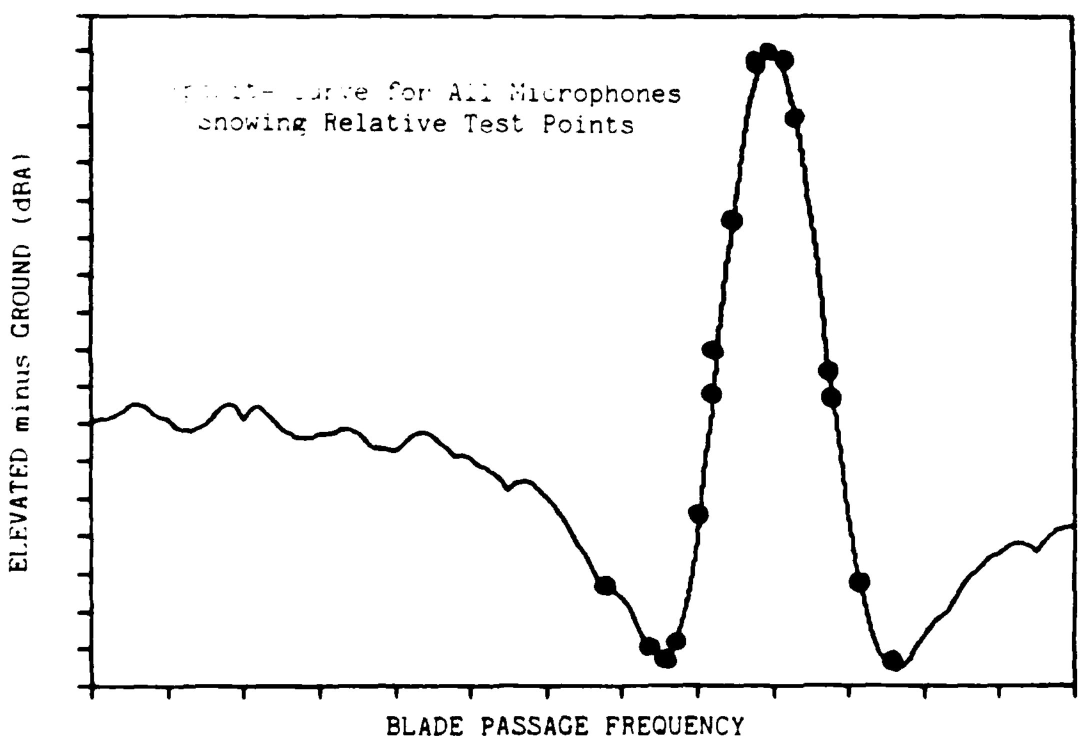


FIGURE . DELTA SPL(H) vs. BPF Curves for C-210 Test





All test runs (events) were simulated takeoffs at 75% power and 100 KIAS. The target altitude over the measurement point was 640 feet AGL. A minimum of six replications were performed for each of the four RPMs tested.

The microphones were rearranged with three elevated microphones at 4.0 feet and three ground-plane microphones over 0.4 meter plates. A series at 2850 RPM, corresponding to a maximum point on the delta SPL(H) versus BPF curve, and a series at 2550, corresponding to a minimum point on the curve, were run for the secondary objective.

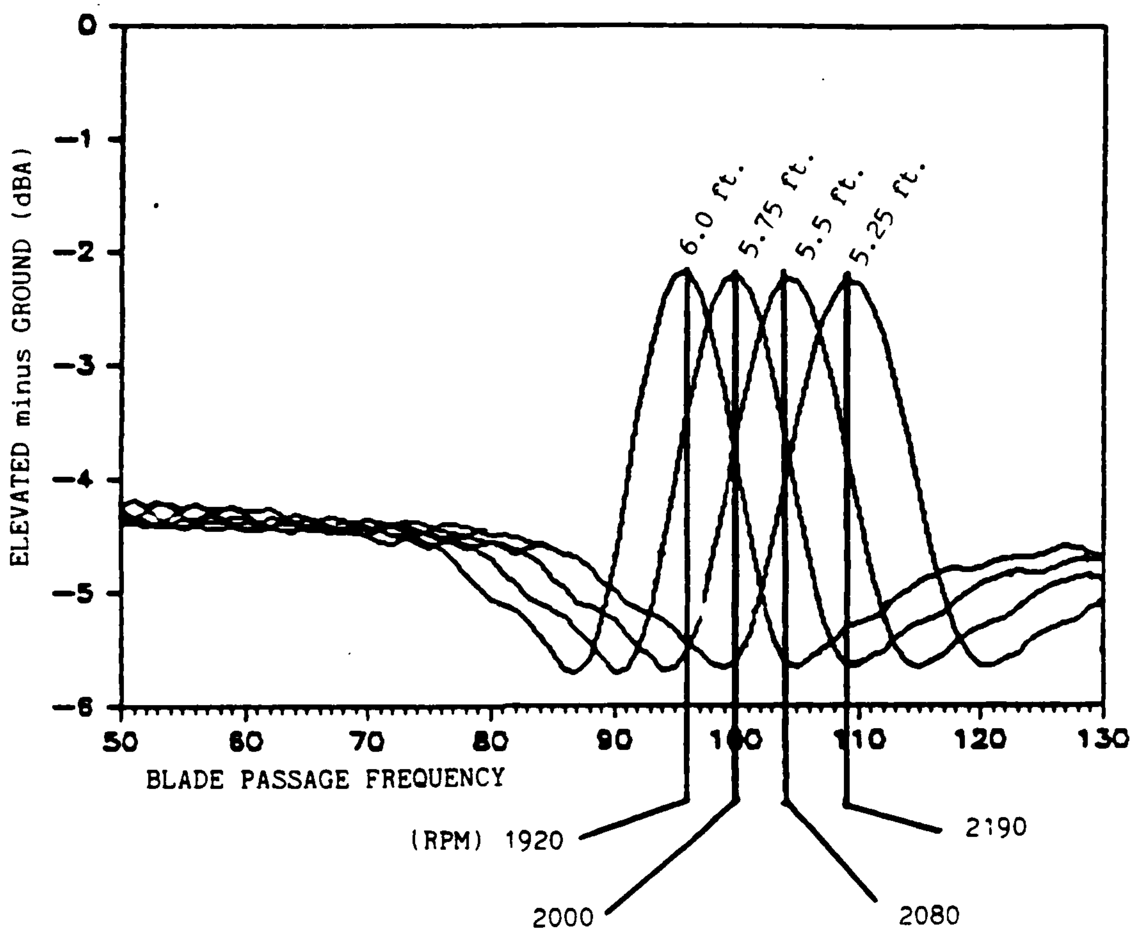
3.6.3 July 30 Test - The U.S. Navy T-34C has a useful RPM range of 1800 to 2200 RPM. As shown in figure 13, microphone heights of 4.0, 5.25, 5.5, 5.75, and 6.0 feet were chosen to address the primary objective. Propeller RPMs of 2190, 2080, 2000, and 1920, with a three-blade propeller, produced blade passage frequencies of 109.5, 104, 100, and 96 respectively. The secondary objective was addressed with the elevated horizontal array at 5.25 feet and test series with RPMs of 2190 and 2000.

All events were simulated takeoffs at 75% torque and 120 KIAS. The target altitude over the measuring point was 520 feet AGL.

3.6.4 August 28 Test - The Cessna Caravan I has a RPM range of approximately 1600 to 1900 while driving a three-blade propeller. Thus with lower available blade passage frequencies, higher microphones were required to achieve data in the areas of interest. Microphone heights of 4.0, 6.0, 6.25, 6.5, and 6.75 feet were chosen along with RPMs of 1900, 1840, 1760, and 1640 (figure 14). The secondary objective was addressed with the three horizontal array microphones at 6.0 feet and an RPM of 1900. The elevated microphones were again re-positioned to 4.0 feet at 1900 RPM for the final test series.

All events were simulated takeoffs at maximum torque and 105 KIAS. Target altitude at the measurement point was 800 feet AGL.

FIGURE 13 DELTA SPL(H) vs. BPF Curves for T-34C Test



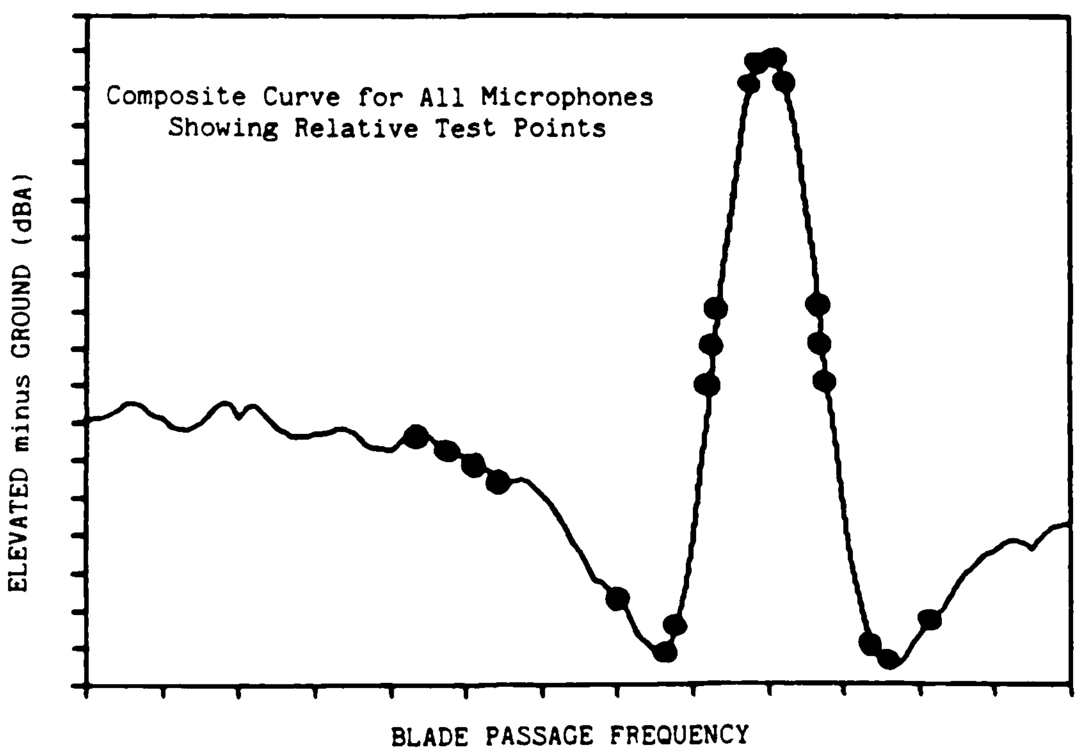
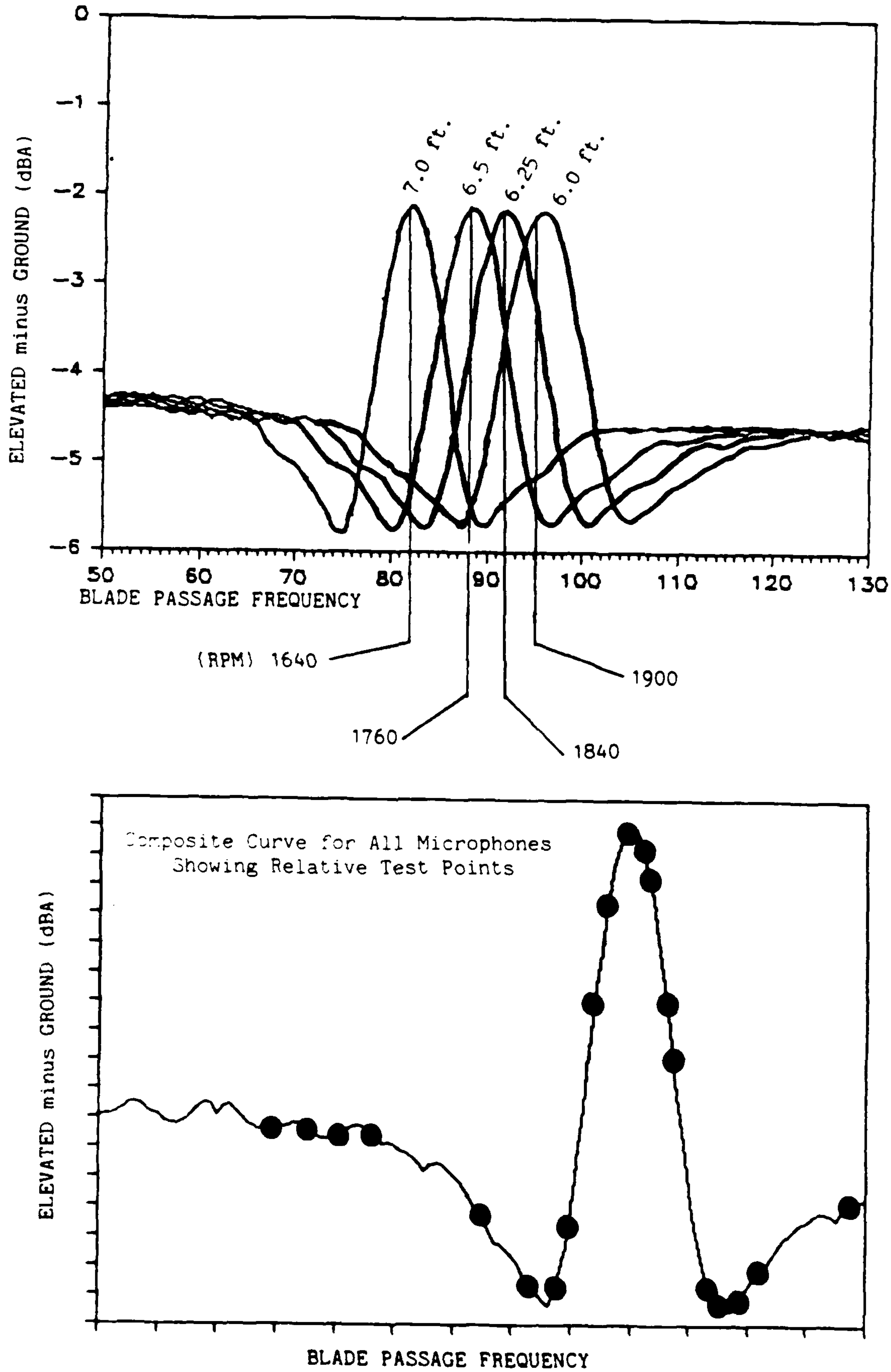


FIGURE [illegible] DELTA SPL(H) vs. BPF Curves for CARAVAN Test



4.0 Data Analysis

4.1 Acoustic Data Reduction System - The analog FM magnetic tape recordings were analyzed at the Department of Transportation, Transportation Systems Center in Cambridge, Massachusetts. The recordings were fed to a GENRAD 1921 Real Time Analyzer set to provide 27, one-third-octave-band (22Hz-11.2KHz) sound pressure levels for each 1/8-second integration period throughout the length of the recorded event. The data were digitized and stored on magnetic disk memory for further processing. Adjustments were made to the stored digitized data to account for deviations from flat frequency response in the measuring and reproduction systems. The spectral data were further adjusted by sloping the spectrum shape at a rate of -3dB per one-third-octave for those bands above 1.25 KHz where the signal to noise ratio was less than 3dB. A-weighted noise indexes calculated with "Slow" dynamic detector response were obtained by further processing the stored 1/8-second data. Four consecutive 1/8-second spectral data records were energy averaged to provide consecutive 1/2-second spectral data records over the length of the stored digitized data. These 1/2-second records were re-averaged using a sliding window 4-sample weighted logarithmic averaging technique to simulate "Slow" exponential sound level meter characteristics. Note that the "as measured" sound pressure levels presented in this preliminary report are uncorrected for temperature, relative humidity and aircraft deviation from the target altitude at the measurement location. The preliminary analysis performed in this report is an examination of the relative differences in the sound pressure levels measured at multiple microphone positions under identical sound source conditions. Thus the data do not require off-reference correction in order to achieve the immediate objective of this preliminary report.

4.1 Test Day Weather

Table 1 summarizes the meteorological conditions during the three days of testing:

Table 1 Meteorology

	WIND-SPEED/GUSTS (MILES PER HOUR)	WIND DIRECTION	TEMPERATURE (FAHRENHEIT)	RELATIVE HUMIDITY (PER CENT)
Jul 9	3-5/12	southerly	75-86	85-86
Jul 30	0-3/9	variable	82-91	63-54
Aug 28	5-12/18	300° steady	78-86	63-48

4.3 July 9 "As Measured" Data

The "as measured" A-weighted sound pressure levels for the July 9 Cessna 210 test are presented in table 2. The test aircraft, although rated at 2850 RPM, could achieve an average of only 2780 RPM --- thus the reduced RPM values indicated in the "A" series. The run-to-run variability within a given test series is largely a result of deviation of the aircraft from the target altitude. This variability also exists in the data from the other two tests. The range of altitudes for the July 9 test was from 569 to 789 feet around a target altitude of 640 feet AGL.

4.4 July 30 "As Measured" Data

The "as measured" data from the July 30 T-34C test are presented in table 3. The aircraft was able to perform at the test RPM values. The range of altitudes at the measurement point was from 424 to 657 feet around a target altitude of 520 feet AGL.

4.5 August 28 "As Measured" Data

The "as measured" A-weighted sound pressure levels from the August 28 Caravan I test are presented in table 4. The range of altitudes at the measurement point is from 819 to 1053 feet against a target altitude of 800 feet AGL. A preliminary assessment of this discrepency indicates that the radar altimeter was consistently 200 feet low.

4.6 Comparison of Elevated Versus Ground-Plane Noise Levels

The differences in A-weighted sound pressure levels between the elevated and ground-plane microphones are presented in tables 5, 6, and 7 for the three tests. The following notes and observations pertain to the data in those tables:

(1) Upon inspection, the data in tables 5, 6, and 7 are reasonably consistent from run-to-run within a given test series. A possible exception is the first seven runs (A1-A6,B7) of the C-210 test (table 5) due to lateral deviation from the reference flight track. The ground-based visual cues were not visible to the pilot after rotation into the climbout phase of the simulated takeoff. Beginning with run B9 and continuing throughout the three tests, real-time course corrections were transmitted to the pilot during each run (see section 3.4.5). In response to the lateral deviation, two additional "A" series runs were made later in the test, thus accounting for the out-of sequence A25 and A26 runs. Until further analysis, runs A1-A6 and B7 should be viewed with caution. These data were excluded from subsequent analyses presented in this report. Fortunately, the A series test conditions were repeated later in the secondary objective phase of the test. Thus, data for the 4.0 ft. microphone at high RPM are available (see table 8).

(2) A scatter plot of measured versus predicted values of delta SPL(H) is shown in figure 15. The measured data from the C-210 test generally agree with the values predicted by the theoretical interference function described in section 3.6.1. However, there is more scatter evident in the data from the T-34C and Caravan Tests. The substantial deviation of measurements from the 4.0 ft. microphones of the T-34C and Caravan tests will require further analysis. Note also the apparent 1.5 to 2.0 dB offset of the C-210 data compared to the data from the T-34C and Caravan tests.

(3) The delta SPL(H) data for the 4.0 ft. data from all three tests are plotted against blade passage frequency in figure 16. Data

from all microphone elevations, normalized to 4.0 feet via the relationship BPF(norm) = BPF (test) x (microphone elevation)/4.0, are plotted in figure 17. These data generally confirm the reinforcement effect on sound pressure levels associated with propeller driven aircraft in the blade passage frequency range of 130 to 165.

(4) The sound pressure levels from the ground-plane microphone with the 36 inch plate are typically 1 dB higher compared to the ground-plane microphone with the 0.4 meter plate for the C-210 test. However, the difference decreases at the lower blade passage frequencies during the turboprop tests.

NOTE: The predicted test data points presented in figures 12B, 13B, and 14B are frequency normalized to a 4.0 foot elevation. All of the predicted test data points were measured. Except as noted in 4.6(1), all of the measured data are presented in figure 15. Similarly, all of the measured data frequency normalized to a 4.0 foot elevation are presented in figure 17. Figure 16, however, contains only the 4.0 foot difference data (as well as the theoretical prediction curve).

Table 2 "As Measured" Noise Levels for July 9 Test of Cessna 210

(maximum A-Weighted sound pressure levels -- slow response)

		Microphone numbers*					
SERIES	RPM/BPF	1	2	3	4	5	6
A1	2790/139.5	87.5	84.5	84.9	86.4	88.9	90.0
A2	2790/139.5	85.7	85.1	84.8	87.0	88.7	90.2
A3	2780/139	85.5	84.4	84.6	86.8	88.5	89.1
A4	2780/139	85.0	85.1	85.1	87.7	89.0	90.0
A5	2780/139	83.1	83.8	83.4	86.1	86.5	87.9
A6	2780/139	84.5	84.5	84.7	87.3	87.6	89.3
A25	2780/139	84.1	83.0	82.2	84.4	86.4	87.9
A26	2780/139	84.5	83.9	82.9	85.1	86.9	88.1
B7	2750/137.5	83.1	84.7	83.1	85.9	86.6	88.1
B8	2750/137.5	84.6	83.2	82.9	84.8	87.1	88.2
B9	2750/137.5	85.2	84.2	83.6	85.6	87.8	88.5
B10	2750/137.5	84.3	83.6	82.8	84.9	86.8	88.2
B11	2750/137.5	85.0	83.4	83.3	84.8	87.4	88.7
B12	2750/137.5	85.6	84.0	83.7	85.5	87.9	88.8
C13	2700/135	82.1	83.2	81.7	83.9	85.9	86.9
C14	2700/135	81.9	82.7	81.2	83.6	85.4	-
C15	2700/135	80.5	81.9	80.2	81.9	83.5	84.4
C16	2700/135	80.7	83.1	80.7	82.4	84.3	85.6
C17	2700/135	82.0	82.6	81.0	83.8	85.1	86.0
C18	2700/135	83.0	82.9	81.6	84.2	85.9	86.6
D19	2550/127.5	78.0	80.1	77.8	78.9	81.8	82.6
D20	2550/127.5	78.1	80.1	-	79.1	81.4	82.0
D21	2550/127.5	79.1	80.7	77.9	79.8	82.3	83.1
D22	2550/127.5	79.1	81.4	79.1	80.5	83.0	84.4
D23	2550/127.5	80.1	82.2	80.2	81.2	83.9	84.7
D24	2550/127.5	78.6	80.9	78.7	79.9	82.4	83.0

*Microphone No. 1 is at 4.0 feet elevation
Microphone No. 2 is at 4.5 feet elevation
Microphone No. 3 is at 3.75 feet elevation
Microphone No. 4 is at 4.25 feet elevation
Microphone No. 5 is a ground-plane with 0.4 meter diameter plate
Microphone No. 6 is a ground-plane with 36 inch diameter plate

Table 3 "As Measured" Noise Levels for July 28 Test of T-34C

(maximum A-weighted sound pressure levels -- slow response)

SERIES	RPM/BPF	Microphone Number* 1	2	3	4	5	6	7
A3	2190/109.5	79.0	76.6	78.2	75.6	78.9	79.6	75.7
A4	2190/109.5	79.0	76.7	78.2	75.8	79.1	79.9	75.7
A5	2190/109.5	79.2	76.8	78.4	75.7	78.9	79.9	75.7
A6	2190/109.5	79.1	76.8	78.3	75.7	78.9	79.6	75.8
A7	2190/109.5	79.1	76.9	78.5	75.7	79.0	79.6	76.0
A8	2190/109.5	78.7	76.4	78.0	75.3	78.6	79.5	75.5
B9	2070/103.5	75.1	75.0	75.5	73.7	75.4	76.1	72.2
B10	2070/103.5	75.4	75.7	76.0	74.3	75.8	76.3	72.8
B11	2070/103.5	75.1	75.1	75.6	73.6	75.3	75.9	72.6
B12	2070/103.5	75.4	75.5	75.8	74.2	75.8	76.6	72.3
B13	2070/103.5	75.6	75.6	75.9	74.2	76.0	76.6	72.5
B14	2070/103.5	75.4	76.1	76.2	74.9	76.2	76.5	73.2
C15	1980/99	71.8	73.3	72.6	72.9	73.6	73.8	69.8
C16	1980/99	72.4	73.9	73.1	73.4	74.3	74.6	70.5
C18	2000/100	73.5	74.9	74.5	74.0	75.1	75.3	71.3
C19	2000/100	72.2	73.6	73.1	72.9	73.7	74.2	70.0
C20	2000/100	73.3	74.7	74.2	73.8	75.2	75.3	70.9
C21	2000/100	72.8	74.5	73.9	73.9	74.7	74.7	70.8
D22	1930/96.5	71.1	72.9	73.1	73.1	73.8	74.1	70.1
D23	1930/96.5	70.6	72.3	71.3	72.5	73.5	73.5	69.2
D24	1930/96.5	70.0	72.0	70.9	72.1	72.9	72.9	-
D25	1930/96.5	70.1	72.1	71.0	72.1	73.0	73.0	68.9
D26	1930/96.5	69.0	70.9	69.8	71.0	71.9	72.3	67.7
D27	1930/96.5	70.6	72.6	71.5	72.5	73.4	73.6	69.3
D28	1930/96.5	70.9	72.7	71.7	72.8	73.8	73.8	69.4

*Microphone No. 1 is at 5.25 feet elevation
Microphone No. 2 is at 5.75 feet elevation
Microphone No. 3 is at 5.5 feet elevation
Microphone No. 4 is at 6.0 feet elevation
Microphone No. 5 is a ground-plane with 0.4 meter diameter plate
Microphone No. 6 is a ground-plane with 36 inch diameter plate
Microphone No. 7 is at 4.0 feet elevation

Table 4 "As Measured" Noise Levels for August 28 Caravan Test

(maximum A-weighted sound pressure levels -- slow response)

		Microphone numbers*						
SERIES	RPM/BPF	1	2	3	4	5	6	7
A1	1900/95	75.4	73.9	74.6	73.0	75.0	75.6	72.2
A2	1900/95	75.7	73.7	74.6	72.9	75.5	75.9	72.2
A3	1900/95	75.7	74.1	75.1	72.9	75.1	75.5	72.4
A4	1900/95	76.2	-	75.9	74.2	76.2	76.7	73.3
A5	1900/95	75.3	74.1	74.9	73.2	75.0	75.4	72.1
A6	1900/95	75.9	75.2	75.7	74.4	75.6	76.0	72.4
A7	1890/94.5	75.4	74.5	75.2	73.5	75.3	76.0	71.9
B8	1840/92	73.2	73.0	73.5	72.5	73.8	74.3	70.9
B9	1840/92	73.3	73.1	73.4	72.4	73.8	74.0	70.5
B10	1840/92	72.4	72.8	73.0	71.6	73.0	73.2	70.2
B11	1840/92	73.3	73.3	73.6	72.3	74.0	73.8	71.1
B12	1840/92	72.5	72.7	72.8	71.9	73.1	73.5	70.0
B13	1840/92	72.3	72.3	72.5	71.6	73.7	73.1	69.5
C14	1760/88	72.2	73.5	72.9	73.7	74.0	74.0	71.3
C15	1760/88	71.0	71.9	71.4	71.7	72.6	72.8	69.1
C16	1760/88	71.4	72.6	71.8	72.4	73.1	73.5	70.1
C17	1760/88	71.9	73.3	74.8	73.2	73.6	73.9	69.9
C18	1760/88	72.1	73.9	72.4	72.9	73.7	73.8	70.2
C19	1760/88	70.7	71.5	71.4	71.8	72.6	72.8	70.0
D20	1640/82	69.9	69.9	69.5	70.0	71.8	72.6	68.1
D21	1640/82	71.2	71.7	70.9	72.2	73.9	73.8	70.0
D22	1640/82	70.6	71.0	70.4	71.4	73.2	73.6	69.7
D23	1640/82	70.0	70.6	69.9	70.9	72.1	72.7	68.2
D25	1640/82	71.4	71.8	71.3	72.3	73.6	73.8	70.7
D26	1640/82	70.4	69.8	69.6	70.1	71.7	72.0	68.3

*Microphone No. 1 is at 6.0 feet elevation
Microphone No. 2 is at 6.5 feet elevation
Microphone No. 3 is at 6.25 feet elevation
Microphone No. 4 is at 6.75 feet elevation
Microphone No. 5 is a ground-plane with 0.4 meter diameter plate
Microphone No. 6 is a ground-plane with 36 inch diameter plate
Microphone No. 7 is at 4.0 feet elevation

Table 5 Ground Versus Elevated Noise Levels for July 9 C-210 Test

(difference in: maximum A-weighted sound pressure levels -- slow response)

Microphone Numbers*

SERIES		(1-5)	(2-5)	(3-5)	(4-5)	(6-5)**
A1		-1.4	-4.4	-4.0	-2.5	1.1
A2		-3.0	-3.6	-3.9	-1.7	1.5
A3		-3.0	-4.1	-3.9	-1.7	0.6
A4		-4.0	-3.9	-3.9	-1.3	1.0
A5		-3.4	-2.7	-3.1	-0.4	1.4
A6		-3.1	-3.1	-2.9	-0.3	1.7
A25		-2.3	-3.4	-4.2	-2.0	1.5
A26		-2.4	-3.0	-4.0	-1.8	1.2
	(AVG)	-2.8	-3.5	-3.7	-1.5	1.25
B7		-3.5	-1.9	-3.5	-0.7	1.5
B8		-2.5	-3.9	-4.2	-2.3	1.1
B9		-2.6	-3.6	-4.2	-2.2	0.7
B10		-2.5	-3.2	-4.0	-1.9	1.4
B11		-2.4	-4.0	-4.1	-2.6	1.3
B12		-2.3	-3.9	-4.2	-2.4	0.9
	(AVG)	-2.6	-3.4	-4.0	-2.0	1.15
C13		-3.8	-2.7	-4.2	-2.0	1.0
C14		-3.5	-2.7	-4.2	-1.8	-
C15		-3.0	-1.6	-3.3	-1.6	0.9
C16		-3.6	-1.2	-3.6	-1.9	1.3
C17		-3.1	-2.5	-4.1	-1.3	0.9
C18		-2.9	-3.0	-4.3	-1.7	0.7
	(AVG)	-3.3	-2.3	-4.0	-1.7	1.0
D19		-3.8	-1.7	-4.0	-2.9	0.8
D20		-3.3	-1.3	-	-2.3	0.6
D21		-3.2	-1.6	-4.4	-2.5	0.8
D22		-3.9	-1.6	-3.9	-2.5	1.4
D23		-3.8	-1.7	-3.7	-2.7	0.8
D24		-3.8	-1.5	-3.7	-2.5	0.6
	(AVG)	-3.6	-1.6	-3.9	-2.6	0.8

*(1-5) 4.0 foot microphone minus primary ground-plane microphone (0.4 meter plate)
(2-5) 4.5 foot microphone minus primary ground-plane "
(3-5) 3.75 foot microphone minus primary ground-plane "
(4-5) 4.25 foot microphone minus primary ground-plane "
**(6-5) secondary ground-plane microphone (36 inch plate) minus primary ground-plane microphone (0.4 meter plate)

Table 6 Ground Versus Elevated Noise Levels for July 30 T-34C Test

(difference in: maximum A-weighted sound pressure levels -- slow response)

Microphone Numbers*

SERIES		(1-5)	(2-5)	(3-5)	4-5)	(7-5)	(6-5)**
A3		+0.1	-2.3	-0.7	-3.3	-3.2	+0.7
A4		-0.1	-2.4	-0.9	-3.3	-3.4	+0.8
A5		+0.3	-2.1	-0.5	-3.2	-3.2	+1.0
A6		+0.2	-2.1	-0.6	-3.2	-3.1	+0.7
A7		+0.1	-2.1	-0.5	-3.3	-3.0	+0.6
A8		+0.1	-2.2	-0.6	-3.3	-3.1	+0.9
	(AVG)	+0.1	-2.2	-0.6	-3.3	-3.2	+0.8
B9		-0.3	-0.4	+0.1	-1.7	-3.2	+0.7
B10		-0.4	-0.1	+0.2	-1.5	-3.0	+0.5
B11		-0.2	-0.2	+0.3	-1.7	-2.7	+0.6
B12		-0.4	-0.3	0	-1.4	-3.5	+0.8
B13		-0.4	-0.4	-0.1	-1.8	-3.5	+0.6
B14		-0.8	-0.1	0	-1.3	-3.0	+3.0
	(AVG)	-0.4	-0.2	+0.1	-1.6	-3.2	+0.6
C15		-1.8	-0.3	-1.0	-0.7	-3.8	+0.2
C16		-1.9	-0.4	-1.2	-0.9	-3.8	+0.3
C18		-1.6	-0.2	-0.6	-1.1	-3.8	+0.2
C19		-1.5	-0.1	-0.6	-0.8	-3.7	+0.5
C20		-1.9	-0.5	-1.0	-1.4	-4.3	+0.1
C21		-1.9	-0.2	-0.8	-0.8	-3.9	0
	(AVG)	-1.8	-0.3	-0.9	-1.0	-3.9	+0.2
D22		-2.7	-0.9	-1.9	-0.7	-3.7	+0.3
D23		-2.9	-1.2	-2.2	-1.0	-4.3	0
D24		-2.9	-0.9	-2.0	-0.8	-	0
D25		-2.9	-0.9	-2.0	-0.9	-4.1	0
D26		-2.9	-1.0	-2.1	-0.9	-4.2	+0.4
D27		-2.8	-0.8	-1.9	-0.9	-4.1	+0.2
D28		-2.9	-1.1	-2.1	-1.0	-4.4	0
	(AVG)	-2.9	-1.0	-2.0	-0.9	-4.1	+0.1

*(1-5) 5.25 foot microphone minus primary ground-plane microphone (0.4 meter plates)
(2-5) 5.75 foot microphone minus primary ground-plane "
(3-5) 5.5 foot microphone minus primary ground-plane "
(4-5) 6.0 foot microphone minus primary ground-plane "
(7-5) 4.0 foot microphone minus primary ground-plane "
**(6-5) secondary ground-plane microphone (36 inch plate) minus primary ground-plane microphone (0.4 meter plates)

Table 7 Ground Versus Elevated Noise Levels for August 28 Caravan Test

(difference in: maximum A-weighted sound pressure levels -- slow response)

Microphone Numbers*

SERIES		(1-5)	(2-5)	(3-5)	(4-5)	(7-5)	(6-5)**
A1		+0.4	-1.1	-0.4	-2.0	-2.8	+0.6
A2		+0.2	-1.8	-0.9	-2.6	-3.3	+0.4
A3		+0.6	-1.0	0	-2.2	-2.7	+0.4
A4		0	-	-0.3	-2.0	-2.9	+0.5
A5		+0.3	-0.9	-0.1	-1.8	-2.9	+0.4
A6		+0.3	-0.4	-0.9	-1.2	-3.2	+0.4
A7		+0.1	-0.8	-0.1	-1.8	-3.4	+0.7
	(AVG)	+0.3	-1.0	-0.4	-1.9	-3.0	+0.5
B8		-0.6	-0.8	-0.3	-1.3	-2.9	+0.5
B9		-0.5	-0.7	-0.4	-1.4	-3.3	+0.2
B10		-0.6	-0.2	0	-1.4	-2.8	+0.2
B11		-0.7	-0.7	-0.4	-1.7	-2.9	-0.2
B12		-0.6	-0.4	-0.3	-1.2	-3.1	+0.4
B13		-1.4	-1.4	-1.2	-2.1	-4.2	-0.6
	(AVG)	-0.7	-0.7	-0.4	-1.5	-3.2	+0.1
C14		-1.8	-0.5	-1.1	-0.3	-2.7	0
C15		-1.6	-0.7	-1.2	-0.9	-3.5	+0.2
C16		-1.7	-0.5	-1.3	-0.7	-3.0	+0.4
C17		-1.7	-0.3	+1.2	-0.4	-3.7	+0.3
C18		-1.6	+0.2	-1.3	-0.8	-3.5	+0.1
C19		-1.9	-1.1	-1.2	-0.8	-2.6	+0.2
	(AVG)	-1.7	-0.5	-0.8	-0.6	-3.2	+0.2
D20		-1.9	-1.9	-2.3	-1.8	-3.7	+0.6
D21		-2.7	-2.2	-3.0	-1.7	-3.9	-0.1
D22		-2.6	-2.2	-2.8	-1.8	-3.5	+0.4
D23		-2.1	-1.5	-2.2	-1.2	-3.9	+0.6
D25		-2.2	-1.8	-2.3	-1.3	-2.9	+0.2
D26		-1.3	-1.9	-2.1	-1.6	-3.4	+0.3
	(AVG)	-2.1	-1.9	-2.4	-1.6	-3.6	+0.3

*(1-5) 6.0 foot microphone minus primary ground-plane microphone (0.4 meter plate)
(2-5) 6.5 foot microphone minus primary ground-plane "
(3-5) 6.25 foot microphone minus primary ground-plane "
(4-5) [illegible].5 foot microphone minus primary ground-plane "
(7-5) 4.0 foot microphone minus primary ground-plane "
**(6-5) secondary ground-plane microphone (36 inch plate) minus primary ground-plane microphone (0.4 meter plate)

FIGURE 15 Measured vs. Predicted Differences in dBA Noise Levels
Between Elevated and Ground Microphones

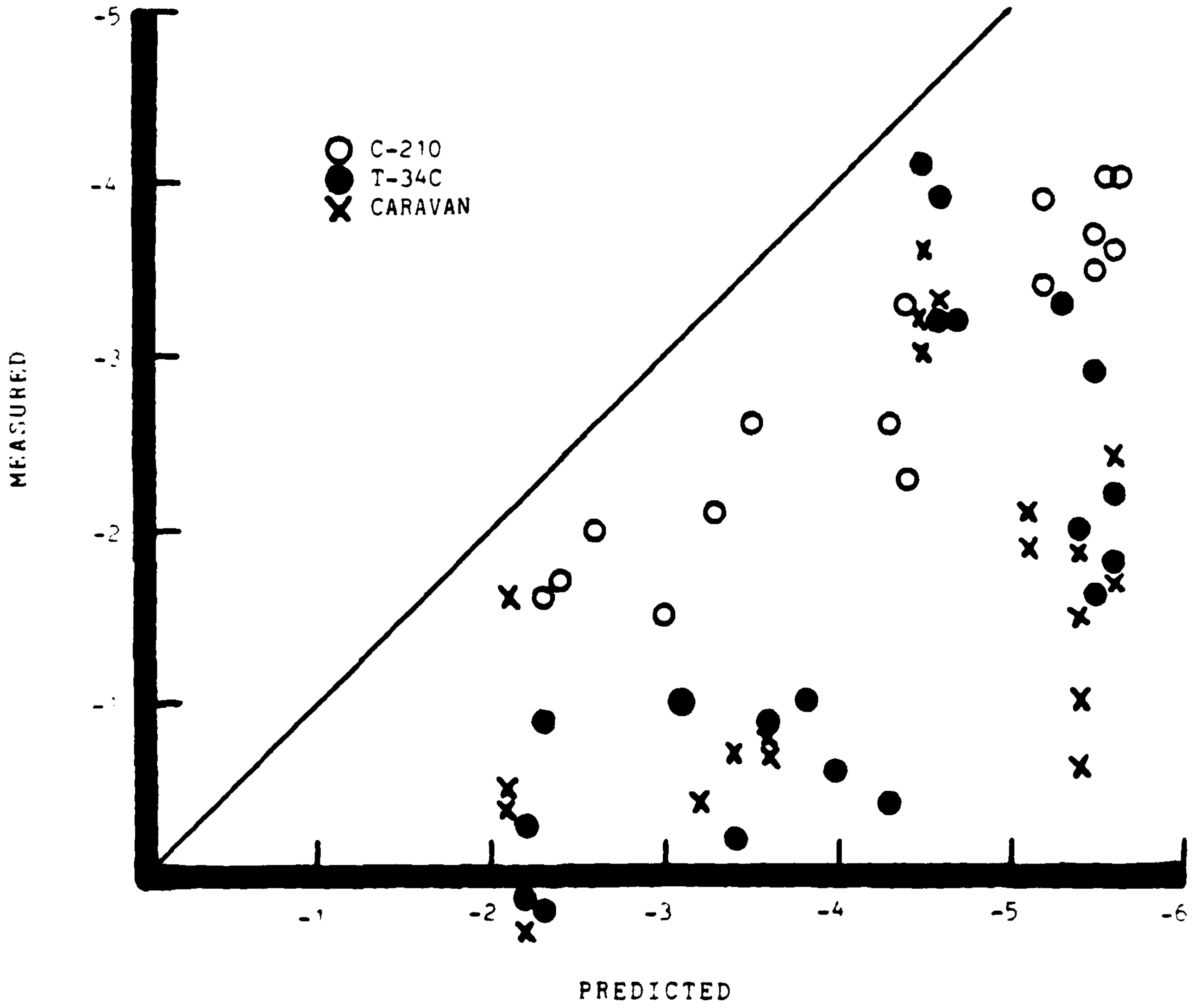


Figure 16 Difference in Noise Levels (elevated minus ground) versus Blade Passage Frequency

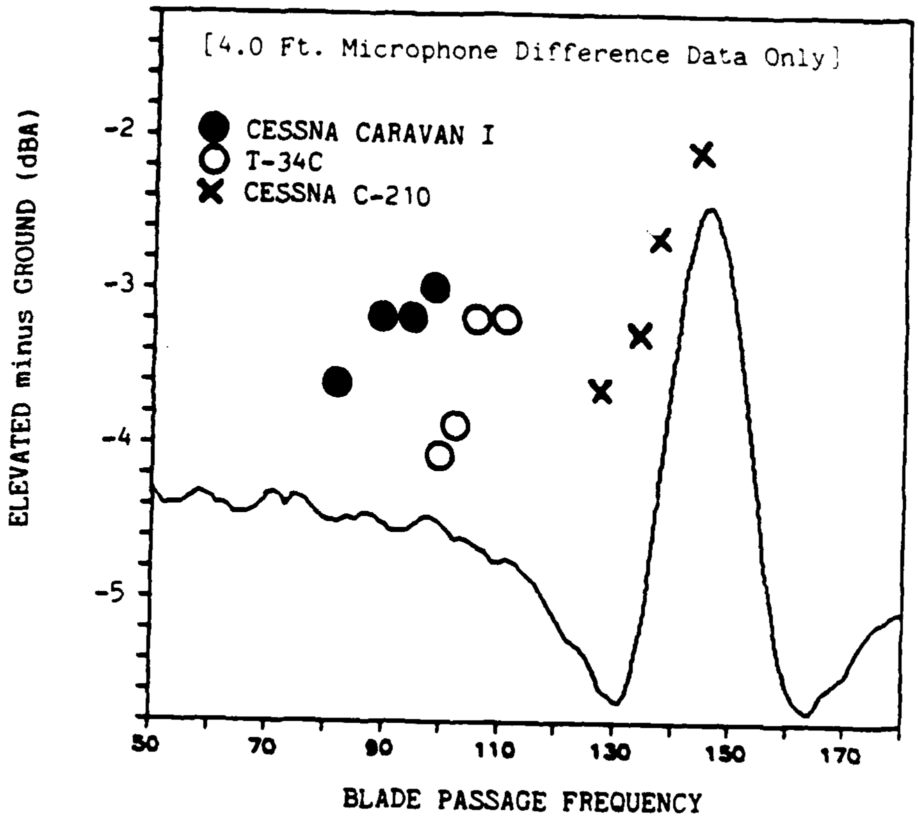
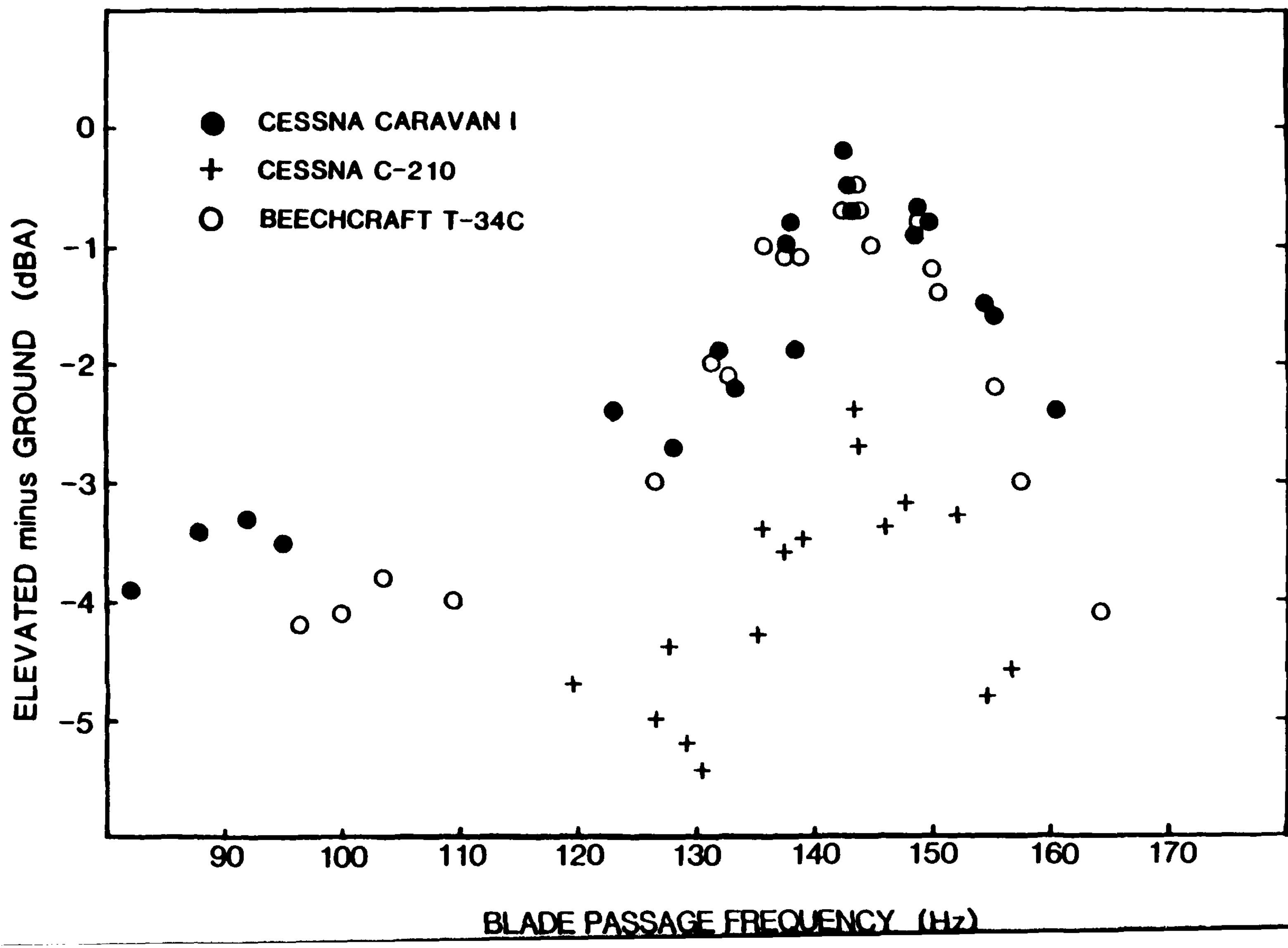


Figure 17 Difference in Noise Levels (elevated minus ground) versus Blade Passage Frequency



4.7 Horizontal Array Data - During the secondary objective phase of each test, the microphones were redeployed in ground-plane and elevated horizontal arrays (see section 3.4.1). The "as measured" noise data from the three tests are presented in tables 8, 9, and 10. These data indicate that there is no clear difference in variability among the elevated array microphones versus ground-plane array microphones.

4.8 Final Remarks - A more comprehensive analysis of the test results will be documented in a future report.

Table 8 "As Measured" Noise Levels From Horizontal Arrays--July 9 C-210 Test
4.0 Feet Elevated versus Ground-Plane
(maximum A-weighted sound pressure levels--slow response)**

		Microphone Numbers*								
Series	RPM/BPF	1A	2A	3A	AVG.	4A	5A	6A	AVG.	delta SPL(H)
E27	2780/139	83.8	83.7		83.75	86.4	86.4		86.4	-2.65
E28	2780/139	87.6	87.6		87.6	89.0	89.1		89.05	-1.45
E29	2780/139	85.9	85.9		85.9	87.6	87.9		87.75	-1.85
E30	2780/139		83.9		83.9	85.9	86.1		86.0	-2.10
E31	2780/139	84.3	84.5		84.4	86.6	86.8		86.7	-2.30
E32	2780/139	86.6	86.4		86.5	88.5	88.8		88.65	-2.15
									(avg.)	-2.1
F33	2550/127.5	78.6	78.6		78.6	82.1	82.0		82.05	-3.45
F34	2550/127.5	79.2	79.0		79.1	83.2	83.9		83.55	-4.45
F35	2550/127.5	79.5	79.4		79.45	83.3	83.6		83.45	-4.00
F36	2550/127.5	78.7	78.8		78.75	82.3	82.9		82.6	-3.85
F37	2550/127.5	79.4	79.5		79.45	82.7	83.0		82.85	-3.40
F38	2550/127.5	79.6	79.5		79.55	83.4	83.3		83.35	-3.80
									(avg.)	-3.8

*Microphone numbers 1A and 2A were at 4.0 feet elevation
Microphone numbers 4A and 5A were ground-plane microphones over 0.4 meter plates
**measured by direct read sound level meters

Table 9 "As Measured" Noise Levels from Horizontal Arrays from July 30 T-34C Test

Elevated versus Ground-Plane Microphones

(maximum A-weighted sound level pressure levels - slow response)

Microphone Numbers*

SERIES	RPM/BPF	1A	2A	3A	(AVG)	(S.D.)**	4A	5A	6A	(AVG)	(S.D.)	delta SPL(H)
E29	2150/107.5	78.3	78.6	78.5	78.74	0.15	78.9	79.1	78.6	78.87	0.25	-0.40
E30	2180/109	74.7	74.6	75.4	74.90	0.44	75.2	75.4	75.3	75.30	0.10	-0.40
E31	2170/108.5	76.4	76.3	76.8	76.50	0.26	76.7	76.9	76.7	76.77	0.12	-0.27
E32	2170/108.5	78.1	77.9	78.1	78.03	0.12	78.1	78.2	77.6	77.97	0.32	+0.06
E33	2170/108.5	77.4	77.1	77.6	77.37	0.25	77.7	77.6	77.1	77.47	0.32	-0.10
E34	2170/108.5	77.8	77.4	78.0	77.73	0.31	78.0	78.1	77.9	78.00	0.10	-0.27
E35	2170/108.5	79.1	79.1	79.2	79.13	0.06	79.2	79.2	79.0	79.13	0.12	0
											(avg)	-0.2
F36	2000/100	71.8	71.9	72.0	71.90	0.10	74.2	74.1	74.0	74.10	0.10	-2.20
F37	2000/100	71.0	71.1	71.3	71.13	0.15	73.6	73.1	73.2	73.30	0.26	-2.17
F38	2000/100	70.0	70.0	70.2	70.07	0.12	72.5	72.3	72.2	72.33	0.15	-2.26
F39	2000/100	70.0	69.8	70.0	69.93	0.12	72.4	72.1	72.0	72.17	0.21	-2.24
F40	2000/100	69.1	69.2	69.6	69.30	0.26	71.9	71.6	71.7	71.73	0.15	-2.43
F41	2000/100	70.6	70.5	70.7	70.60	0.10	72.7	72.7	72.5	72.63	0.12	-2.03
											(avg)	-2.2

*Microphone numbers 1A, 2A and 3A were at 5.25 feet elevation
 Microphone numbers 4A, 5A and 6A were ground-plane microphones on 0.4 meter plates

**Standard Deviation

Table 10a "As Measured" Noise Levels from Horizontal Arrays--August 28 Caravan Test

4.0 Feet Elevated versus Ground-Plane

(maximum A-weighted sound pressure levels--slow response)

Microphone Numbers*

SERIES	RPM/BPF	1A	2A	3A	(AVG)	(S.D.)	4A	5A	6A	(AVG)	(S.D.)	delta SPL(H)
F34	1900/95	72.4	71.7	72.0	72.03	0.35	75.4	75.2	74.9	75.17	0.25	-3.14
F35	1900/95	72.4	71.8	71.9	72.03	0.32	75.2	74.9	74.5	74.87	0.35	-2.84
F36	1900/95	72.7	72.3	72.5	72.50	0.20	75.6	75.4	75.2	75.40	0.20	-2.90
F37	1900/95	74.0	73.6	73.7	73.77	0.21	76.7	76.5	76.2	76.47	0.25	-2.70
F38	1900/95	71.5	71.4	71.2	71.37	0.15	74.7	74.7	74.2	74.53	0.29	-3.16
F39	1900/95	70.6	69.6	70.4	70.20	0.53	73.0	73.1	73.5	73.20	0.26	-3.00
F40	1900/95	71.8	71.2	71.8	71.60	0.35	74.7	74.6	74.6	74.63	0.06	-3.03
											(avg)	-3.0

*Microphone numbers 1A, 2A and 3A were at 4 feet elevation
Microphone numbers 4A, 5A and 6A were ground-plane microphones on 0.4 meter plates

Table 10b "As Measured" Noise Levels from Horizontal Arrays -- August 28 Caravan Test
6.0 Feet Elevated versus Ground-Plane

(maximum A-Weighted sound pressure levels -- slow response)

Microphone Numbers*

SERIES	RPM/BPF	1A	2A	3A	(AVG)	(S.D.)	4A	5A	6A	(AVG)	(S.D.)	DeltaSPL(H)
E27	1900/95	75.0	74.5	74.8	74.77	0.25	75.0	75.0	74.8	74.93	0.12	-0.16
E28	1900/95	75.0	74.6	75.0	74.87	0.23	75.2	75.2	74.9	75.10	0.17	-0.23
E29	1900/95	75.9	75.8	75.7	75.80	0.10	76.4	76.0	75.6	76.00	0.40	-0.20
E30	1900/95	75.4	75.0	75.0	75.13	0.23	75.7	75.5	75.1	75.43	0.31	-0.30
E31	1900/95	74.8	74.6	74.5	74.63	0.15	75.3	75.1	74.6	75.00	0.36	-0.37
E32	1900/95	75.3	75.1	75.2	75.20	0.10	75.8	75.4	75.4	75.53	0.23	-0.33
E33	1900/95	75.0	74.7	74.8	74.83	0.15	75.6	75.3	75.1	75.33	0.25	-0.50
											Avg	-0.3

*Microphone numbers 1A, 2A, and3A were at 6.0 feet elevation
Microphone numbers 4A, 5A, and 6A were ground-plane microphone on 0.4 meter plates

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